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Authors: Kaprus', Igor J., Paśnik, Grzegorz, and Weiner, Wanda M.

Source: Florida Entomologist, 97(2) : 465-476

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/024.097.0217

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"SEXUALLY ARMED" SPECIES OF THE GENUS *PROTAPHORURA* (COLLEMBOLA: ONYCHIURIDAE)

IGOR J. KAPRUS[1,*], GRZEGORZ PAŚNIK[2] AND WANDA M. WEINER[2]
[1]State Museum of Natural History, Ukrainian National Academy of Sciences, Teatral'na St. 18, UA-79008 L'viv, Ukraine

[2]Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Sławkowska 17, Pl-31016 Kraków, Poland

*Corresponding author; E-mail: i-kaprus@mail.ru

ABSTRACT

Species possessing mvo: *Protaphorura bakhchisaraica* **sp. nov.** and *P. salsa* **sp. nov.** from two peculiar habitats: xerothermic bushes in Ukraine (Crimea) and a salt lake shore in Russia (South Siberia) are described. Two other species with this organ, *Protaphorura ianstachia* Yosii, 1972 and *P. stiriaca* (Stach, 1946), are redescribed, discussed and their lectotypes designed. An identification key to all known *Protaphorura* species having mvo is given. The structure and arrangement of the organ is applied as a sharp diagnostic character at the species level.

Key Words: Protaphorurini, taxonomy, chaetotaxy, abdominal sterna, identification key

RESUMEN

Se describen como nuevas especies para la ciencia *Protaphorura bakhchisaraica* **sp. nov** y *P. salsa* **sp. nov.** , especies que poseen machos con organo ventral y que proceden de la maquia de Ucrania (Crimea) y de la costa de un lago salado de Rusia (Siberia). Se redescriben tambien dos especies mas con este organo: *Protaphorura ianstachia* Yosii, 1972 and *P. stiriaca* (Stach, 1946), y se designan los lectotipos de ambas. En este trabajo se da una clave mundial para todas las especies de *Protaphorura* con organo ventral en los machos. La estructura y disposicion en diferentes esternitos de las quetas del organo ventral se utiliza como on buen caracter para la distincion entre las especies.

Palabras Clave: Protaphorurini, taxonomia, quetotaxia, esternitos abdominales, clave de 36 identificacion

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In Onychiuridae s. str., (= Onychiurinae sensu Deharveng 2004) the male ventral organ (mvo) so far has been found in all tribes, although only in one species for the tribe Oligaphorurini. Originally, the organ was discovered and described by Stach (1934) as the "male ventral organ" (in German – "Bauchorgan eines Männchens") in the following species: *Onychiuroides granulosus* (Stach, 1930), *Onychiuroides postumicus* (Bonet, 1931), *Onychiurus rectospinatus* Stach, 1922, *Onychiurus stillicidii* (Schiődte, 1849) and *Protaphorura ianstachi* (Yosii 1972).

The function of mvo is not known until now. However, Stach (1934) and Pomorski (1998) believed that the structure of the organ provides a good diagnostic character at the species level.

The mvo consists of modified chaetae (the modifications are sometimes very considerable) and it is situated on different abdominal sterna: Abd. I (on ventral tube), II, II–III, II–IV and VI (anal valves) depending on the species. Snider (1977), and Weiner & Stomp (1995) showed that the mvo undergoes changes from instar to instar, modifying the shape of chaetae, but preserving their number and position.

Even within the genus *Protaphorura* Absolon, 1901 the mvo seems to be a convergent character since it occurs in species which are very different in the pseudocellar formula and other essential characters. Thus, the species with "sexually armed" males compose an artificial, although well defined, group.

The presence of modified chaetae in mature males is not a common phenomenon for the genus *Protaphorura.* Up to now only 10 species equipped with such an organ were known. In our materials from Ukraine and Russia we found 2 species new to science. The identification key to the *Protaphorura*-species with the mvo provided herein can facilitate their determination.

MATERIAL AND METHODS

Specimens were mounted in Marc Andre II and Faur solution, after clearing in lactophenol,

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and were studied using Olympus and Leica microscopes. Material is housed in the State Museum of Natural History, Ukrainian National Academy of Sciences, L'viv, Ukraine (SNHM), Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland (ISEA) and Moscow Pedagogical State University, Moscow, Russia (MPSU).

Morphological terms. Labial types are named after Fjellberg (1999). Tibiotarsal formula is presented after Deharveng (1983). Chaetae on furcal area are notated after Weiner (1996). Chaetae M/s ratio on abdominal tergum V and chaetae formula on thoracic tergum I are notated after Gisin (1952).

Abbreviations used in descriptions: Abd. – abdominal segments, Th. – thoracic segments, mvo – male ventral organ, Ant. – antennal segments, AIIIO – sensory organ of Ant. III, PAO – postantennal organ, pso – pseudocellus, psx –parapseudocellus, psp – pseudopore, 1^{m} – single psx or psp in medial position.

Taxonomy

Onychiuridae: Onychiurinae: Protaphorurini

List of *Protaphorura* species with MVO:

P. ajudagi Pomorski, Skarżyński and Kaprus' 1998 – Ukraine, Crimea;

P. bakhchisaraica **sp. nov.** – Ukraine, Crimea;

P. christiani Pomorski, Leithner and Bruckner 2003 – Austria, Kolmberg;

P. eichhorni (Gisin 1954) – Luxembourg, Kleepesch, Neuwies etc.;

P. ianstachi (Yosii 1972) – Georgia, Caucasus, Tbilisi;

P. januarii (Weiner 1977) – Poland, Pieniny Mts.;

P. kopetdagi Pomorski 1994 – Turkmenia, Kopetdag Mts.;

P. minima Sun, Zhang and Wu 2013 – China, Heilongjiang, Tongjiang;

P. salsa **sp. nov.** – Russia, South-West Siberia.

P. stiriaca (Stach 1946) – Austria, Upper Stiria, Admont;

P. stogovi Pomorski 1993 – North of European Russia (Babenko, pers. com.);

P. tricampata (Gisin 1956) – Europe (after Bellinger et al. 2006-2013);

Protaphorura bakhchisaraica **sp. nov.** (Figs. 1–8, 31, 34)

Type Material

Holotype male Ukraine: Crimea, Plateau Tshufut-Kale near Bakhchisarai city, 6-X-2005, dry bush, soil, leg. Ju. Chernobay (SNHM). PARATYPES 2 femals, data same as Holotype (SNHM). Other material. 3 males and 2 females, Ukraine, Crimea, Rybachye village, 9-IX-1997, maquis, under stones, leg. I. Kaprus', D. Skarżyński and R.J. Pomorski.

Diagnosis

PAO with 24–30 simple vesicles. Pso formula: 32/01(2)2/331(2)32 dorsally, 2/000/0000 ventrally, subcoxae without pso. Submedial pso a and b on Abd. terga I–II located far apart. Psx formula on Abd. sterna: 110001^{m}. Th. tergum I with 7–9+7–9 chaetae, chaeta m absent. Chaetae s´ absent on Abd. terga I–III and V. Mvo on Abd. sterna II and III with 2+2 and 2+2 modified chaetae, and 4+4 thickened chaetae on ventral tube.

Description

Holotype (male) length 1.17 mm, length of paratypes: 1.14–1.47 mm (females). Shape of body typical of the genus: cylindrical with strong anal spines on papillae (Fig. 1). Colour in alcohol white. Granulation more or less uniform, distinct. Base of antennae well marked. Usually 11–12 grains around each pso.

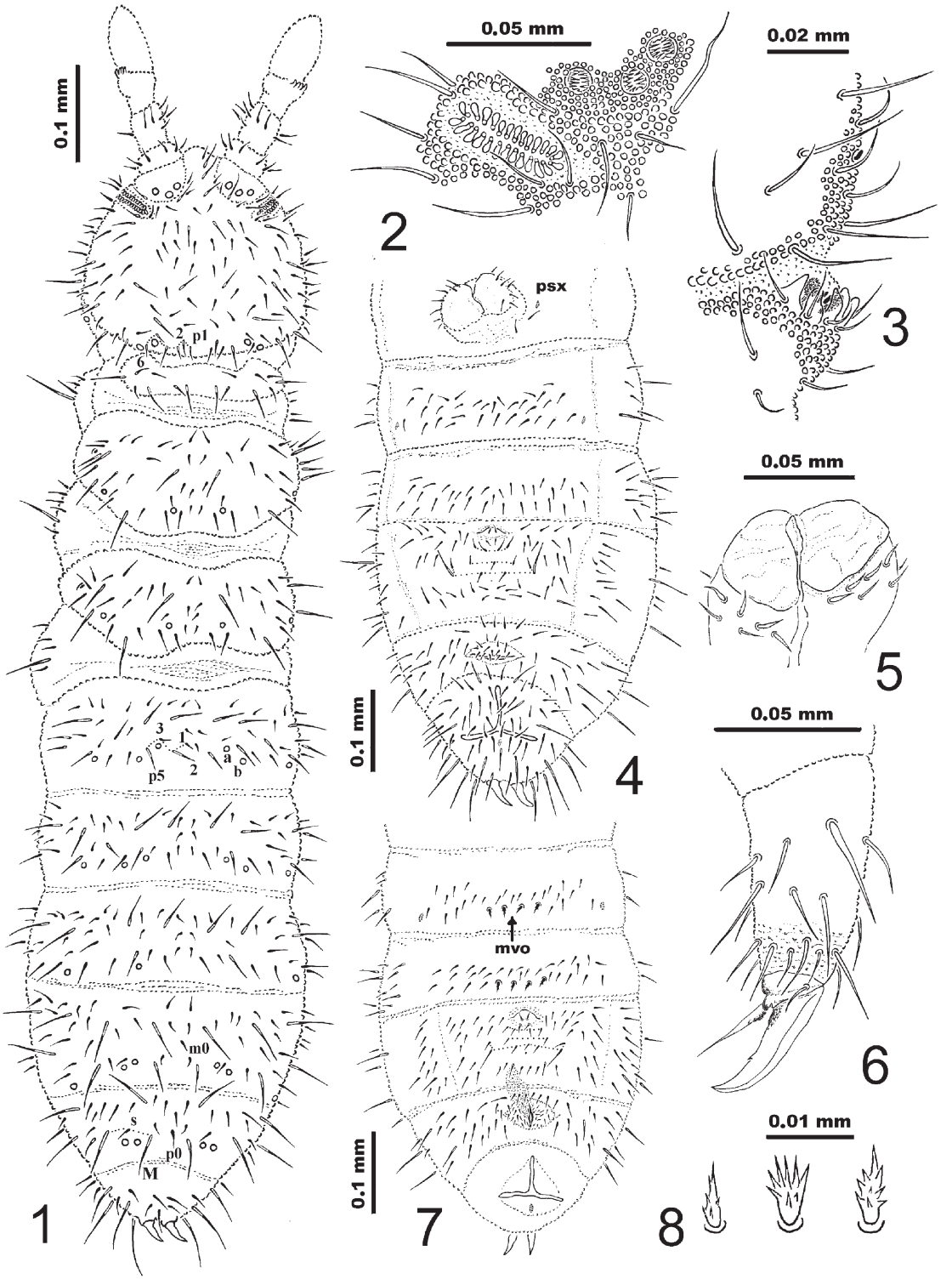
Antennae shorter than head. Ant. I with 10 chaetae, Ant. II with 17–18 chaetae. AIIIO with five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present (Fig. 3). Ant. IV with subapical organite, without clear cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae (Fig. 3). Ventrally Ant. IV with numerous chaetae (ca. 65). Sensilla on Ant. IV indistinct.

PAO with 24–30 simple vesicles (Fig. 2). Labral formula of chaetae: 4/342. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A.

Pso formula dorsally: 32/01(2)2/331(2)32; ventrally: 2/000/0000. Subcoxae 1 of I–III legs without pso. Submedial pso a and b on Abd. terga I–II located far apart, i.e. pso b laterally from chaetae p5. Psx present on Abd. sterna I, II and on upper anal valve ($0/000/110001^{m}$) (Figs. 4 and 7). Formula psp (size almost as 1/4 of pso) dorsally: 0/011/0111, ventrally: $0/?1?/01^{m}1^{m}1^{m}$.

Dorsal chaetotaxy, usually asymmetrical, as in Fig. 1, well differentiated into macrochaetae and microchaetae. Sensory chaetae s' indistinct. On head p2 chaetae displaced forward in relation to p1 and p3. Chaetae p6 on head between pso a and b. Th. tergum I with 7–9+7–9 chaetae, chaeta m absent (i2–, –1–). Th. terga II and III with lateral microsensilla. Chaetae s' absent on Abd. terga I–III and V. Abd. tergum IV with me-

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Figs. 1–8. *Protaphorura bakhchisaraica* **sp. nov.** (1) habitus and dorsal chaetotaxy; (2) PAO and anterior cephalic pseudocelli; (3) antennal III sense organ; (4) chaetotaxy of Abd. sterna I–VI (female); (5) distal part of ventral tube; (6) tibiotarsal chaetotaxy and claw of leg III; (7) chaetotaxy of Abd. sterna II–V (male); (8) modified chaetae of mvo.

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dial chaeta m_0. Abd. tergum V with medial chaetae p_0 and m_0 (sometimes m_0 absent). Abd. tergum VI with 1 medial chaeta m_0. Base of chaetae in front of anal spines in subconvergent forward arrangement (Fig. 1). M/s ratio on Abd. tergum V as 10.5–11.4/9.0–9.5 (anal spines = 10). Anal spines 0.95–1.07 times longer than inner edge of claw and 2.7–2.8 times longer than their basal diameter.

Ventral chaetotaxy. Th. sterna I–III without chaetae. Ventral chaetotaxy of Abd. sterna I–VI as in Figs. 4 and 7. Ventral tube with ca. 7–8+7–8 chaetae (4+4 thickened) (Fig. 5), and 2+2 chaetae at base. Furcal rudiment: cuticular fold (on the anterior edge of the sternum) with 1+1 microchaetae and 1+1 microchaetae at the base (i.e., 2 + 2 dental microchaetae in 2 rows). Chaetotaxy of manubrial field variable: 4 chaetae present in ma-row, 2–3 chaetae in mm-row and 6–7 chaetae in mp-row (Figs. 4 and 7). In adult males mvo present as 2 + 2 and 2 + 2 modified chaetae developed on Abd. sterna II and III (Figs. 7, 8 and 31) and additionally ventral tube with 4+4 thickened chaetae (Fig. 5). Male genital plate as in Fig. 34.

Legs. Subcoxae 1 of I, II and III legs with 5, 6–7, 6–7 chaetae, subcoxae 2 with 1, 4, 4, coxae with 4, 10, 14, trochanters with 11, 10, 9, femora with 18, 18, 17, tibiotarsi with four rows of chaetae (A+T)(=distal whorl)+B+C: 11+8+3, 11+8+3, 11+8+4 chaetae respectively (Fig. 6).

Claw with (rarely without) small denticle in the ½ of inner edge of claw (Fig. 6). Empodial appendage almost of the same length as inner edge of claw, without basal lamella (Fig. 6).

Etymology

The name of the new species refers to Bakhchisarai, the former capital of Crimean Tatars and the place where the type specimens originated.

Discussion

The new species seems to be the most similar in the structure of mvo to *P. kopetdagi* from the Central Asia desert. Both species have the modified chaetae on Abd. sterna II and III (2+2 and 2+2) and are characterized by lacking the pso on all subcoxae 1's, but can be easily distinguished by different pso formulas (32/01(2)2/331(2)32 dorsally and 2/000/0000 ventrally in the new species, 32/022/33332 dorsally and 2/000/0001 ventrally in *P. kopetdagi*), by the shape of chaetae on ventral tube (4+4 thickened chaetae in the new species and absent these chaetae in *P. kopetdagi*) and also shape of mvo chaetae.

The new species is also similar to the Siberian *P. salsa* **sp. nov.** by lacking the pso on all subcoxae 1, chaetae on Abd. terga I–III, and V, and by the presence 2 + 2 pso on the head ventrally. They differ in the dorsal pso formula and also by the number of modified chaetae in mvo on Abd. sternum III (see also description of *P. salsa*).

Among the *Protaphorura* species with the mvo, the only sympatric one is *P. ajudagi*. Specimens of the both species have the same number of dorsal and ventral pso. However, they clearly differ by the number and the shape of mvo modified chaetae and their locations (see the key).

Protaphorura salsa **sp. nov.**
(Figs. 9–15, 27–30, 33)

Type Material

Holotype male preadult Russia: S-W Novosibirsk district, 25 km from Karasuk town, shore of Krotovaya Lyaga lake with salt soil, N 53º 43' 21" E 77º 52' 06", 23-IX-1988, zone with dominated saltmarsh rush – *Juncus gerardii*, decomposing hay, leg. W.M. Weiner & S.K. Stebaeva (ISEA). PARATYPES 11 females, 7 males preadult, 2 juveniles, data same as Holotype (ISEA – 11 paratypes, SNHM – 6 paratypes, MSPU – 3 paratypes).

Diagnosis

PAO with 28–35 simple vesicles. Pso formula: 33/022/3324(3)3 dorsally, 2/000/0001 ventrally, subcoxae without pso. Mvo on Abd. sterna II and III with 2+2 and 1+1 modified chaetae. Submedial pso a and b on Abd. terga I and II located close together. Psx formula on Abd. sterna: 110001^{m}. Th. tergum I with 8–9+8–9 chaetae, chaeta m absent. Chaetae s´ absent on Abd. terga I–III and V.

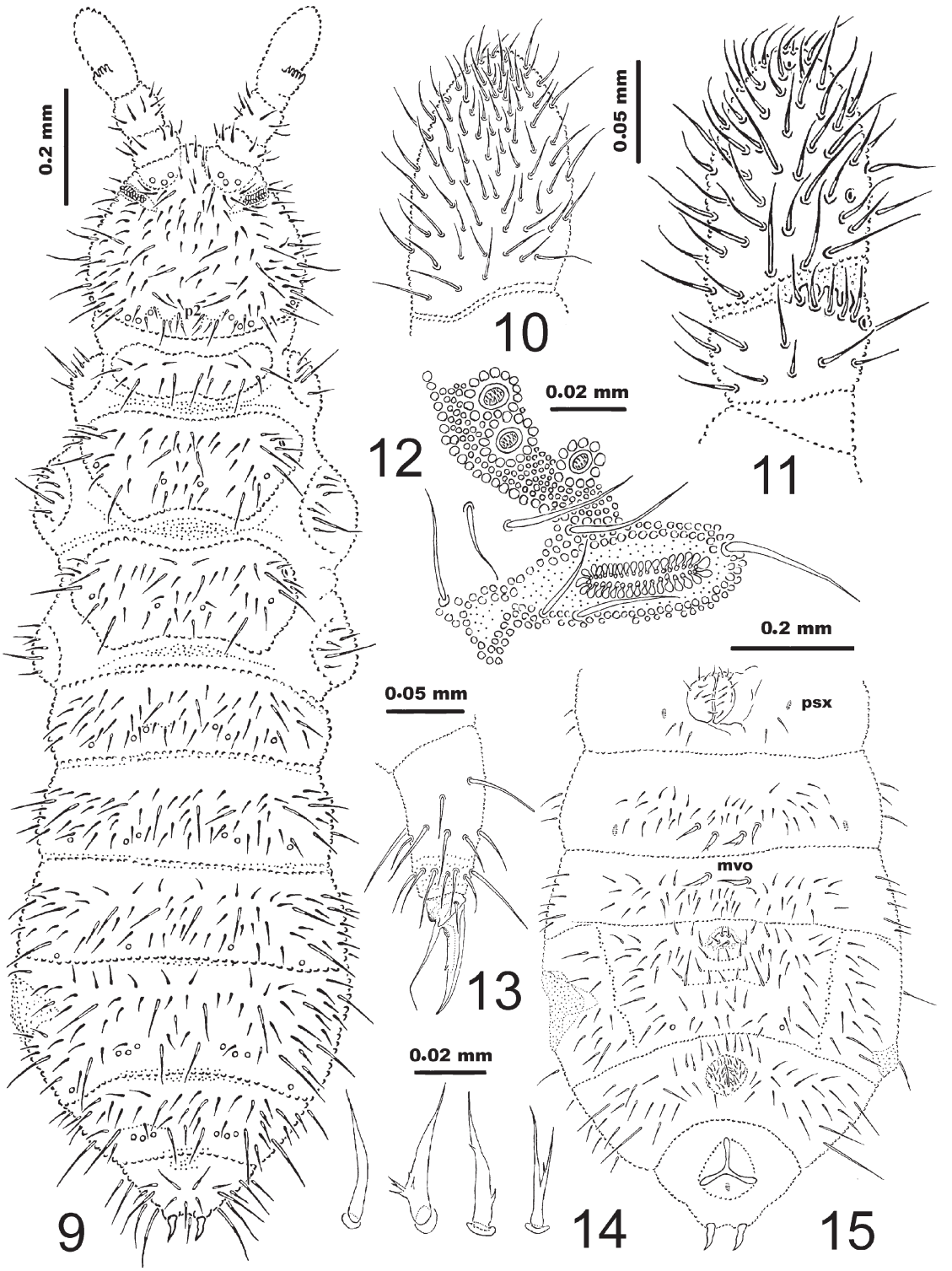
Description

Holotype (preadult male) length 1.94 mm, length of paratypes: 2.0–2.31 mm (females), 1.72–2.32 mm (males). Shape of body typical for the genus: cylindrical with strong anal spines on distinct papillae (Fig. 9). Colour in alcohol white. Granulation distinct more or less uniform. Base of antennae well marked. Usually 11–13 grains around each pso.

Antennae of almost the same length as head. Ant. I with 9–12 chaetae, Ant. II with 17–18 chaetae. AIIIO with five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present (Figs. 11 and 27). Ant. IV with subapical organite in cavity, without cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ant. IV with very numerous ventral chaetae (ca. 85) (Fig. 10). Sensilla on Ant. IV indistinct.

PAO with 28–35 simple vesicles (Figs. 12 and 28). Labral formula of chaetae: 4/342. Maxil-

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Figs. 9–15. *Protaphorura salsa* **sp. nov.** (9) habitus and dorsal chaetotaxy; (10) ventral side of Ant. IV; (11) dorsal side of Ant. III–IV; (12) PAO and anterior cephalic pseudocelli; (13) tibiotarsal chaetotaxy and claw of leg III; (14) modified chaetae of mvo; (15) chaetotaxy of Abd. sterna I–V.

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lary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A. Pso formula dorsally: 33/022/3324(3)3 (Abd. IV with 3(2) pso in medial and one in dorsolateral positions, lateral pso absent); ventrally: 2/000/0001 (Figs. 9 and 15). Subcoxae 1 of I–III legs without pso. Submedial pso a and b on Abd. terga I–II placed close together. Psx present on Abd. sterna I, II and on upper anal valve (psx formula $0/000/110001^{m}$) (Fig. 15). Psp (size almost as 2/3 of pso) formula dorsally: 0/011/1111, ventrally: $0/111/01^{m}1^{m}1^{m}$ (^{m}– single psp in medial position: Abd. II in anterior part, in Abd. III in posterior part, in Abd. IV at base of manubrial area), coxae with 1 psp each.

Dorsal chaetotaxy, not fully symmetrical, as in Fig. 9, well differentiated into macrochaetae and microchaetae. Sensory chaetae s indistinct. On head p2 chaetae displaced forward in relation to p1 and p3. Chaetae p6 on head between pso a and b. Th. tergum I with 8–9+8–9 chaetae, chaeta m absent on i1(2). Th. terga II and III with lateral microsensilla. Chaetae s' absent on Abd. terga I–III and V. Abd. tergum IV with medial chaeta m_0 (rarely absent). Abd. tergum V with medial chaetae p_0 and m_0 (rarely absent m_0). Abd. tergum VI with 1 medial chaeta (m_0). Base of chaetae in front of anal spines in subconvergent forward arrangement. M/s ratio on Abd. tergum V as 21.6 /8.6 (anal spines = 10). Anal spines 1.4–1.56 times longer than inner edge of claw and 2–2.5 times longer than their basal diameter.

Ventral chaetotaxy. Th. sterna I–III without chaetae. Chaetotaxy of Abd. sterna I–VI as in Fig. 15. Ventral tube with ca. 9+9 chaetae, and 2+3 chaetae at base (Fig. 15). Furcal rudiment: cuticular fold (on the anterior edge of the sternum) with 2+2 dental microchaetae. Chaetotaxy of manubrial field variable: 4 chaetae present in ma-row, 2–4 chaetae in mm-row and 6–7 chaetae in mp-row (Figs. 15 and 29). Mvo present: in preadult males on Abd. sterna II and III as 2+2 and 1+1 modified chaetae respectively (Figs. 14, 15 and 30). Adult male not found in the material (Fig. 33).

Legs. Subcoxae 1 of I, II and III legs with 5–6, 6–7, 6–7 chaetae, subcoxae 2 with 1, 5, 4–3) , coxae with 4, 10–11, 14–13), trochanters with 11, 11, 10, femora with 19 each, tibiotarsi with four rows of chaetae (A+T)(=distal whorl)+B+C: 11+8+3, 11+8+3, 11+8+4 chaetae respectively. Claw narrow and long, always with strong denticle in the 1/2 of inner edge of claw (Fig. 13). Empodial appendage almost equal in length to inner edge of claw, without basal lamella. (Fig. 13).

Etymology

The name of the new species refers to the salty (in Latin: *salsus*) type of locality.

Discussion

The shape of mvo in a new species is similar to *P. christianseni* and *P. stiriaca*. All three species possess modified chaetae on Abd. sterna II (2+2) and III (1+1), but they differ in the dorsal and ventral pso formula: 33/022/33324(3)3 and 2/000/0001 in the new species, 33/012/33333 and 1/000/0000 in *P. christianseni*, 32/001/23232 and ventrally lack pso in *P. stiriaca*. The new species and *P. stiriaca* have no pso on subcoxae 1 (vs. 1,1,1 in *P. christianseni*). See also the discussion of *P. bakhchisaraica* **sp. nov.**

Protaphorura ianstachi (Yosii, 1972) (Figs. 16–20)

Onychiurus octopunctatus (Tullberg, 1876) sensu Stach (1934): 134–138, partim

Type Material

Lectotype (by present designation): male Georgia: Mtsheta, Armazi Gorge NW Tbilisi, with the original label: "Caucasus, Mechet, Wąwóz armarski, 28-IV-1918, leg. Roszkowski; *Onychiurus octopunctatus*, det. J. Stach". The only one preserved specimen is not in good condition and for that only some details are given.

Redescription

Lectotype (male) length 1.1 mm. Shape of body typical for the genus: cylindrical with strong anal spines on distinct papillae (Fig. 16). Granulation more or less uniform, distinct. Base of antennae well marked.

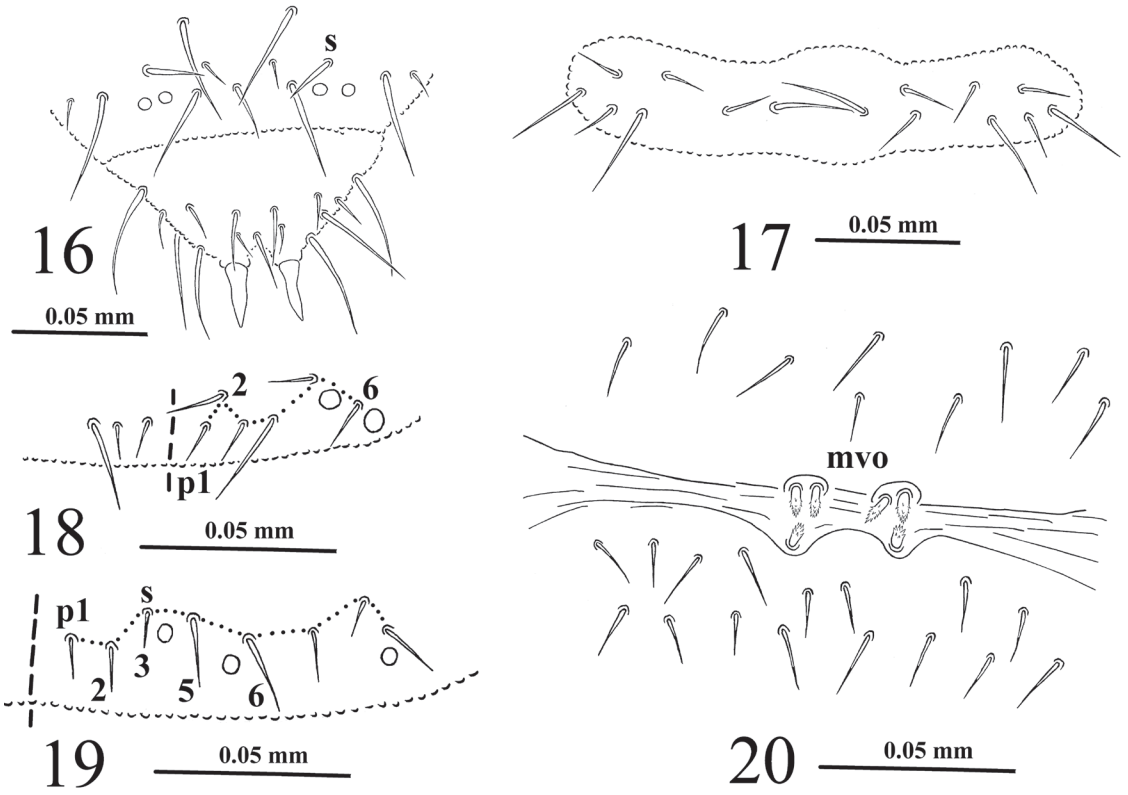
Antennae of almost the same length as head. AIIIO with five guard chaetae, five papillae, two smooth sensory rods, two straight and granulated sensory clubs, ventro-lateral microsensillum present. Ant. IV with subapical organite in cavity, without cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Ventrally Ant. IV with numerous chaetae. Sensilla indistinct on Ant. IV.

PAO with about 28 simple vesicles. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labial palp of type A.

Pso formula dorsally: 42/022/33332, ventrally: 2/000/0000. Subcoxae 1 of I–III legs with 1,1,1 pso. Submedial pso a and b on Abd. terga I–II located far apart (Fig. 19), almost the same distance as on Abd. tergum III. Psp invisible.

Dorsal chaetotaxy well differentiated into macrochaetae and microchaetae. On head p2 chaetae displaced forward in relation to p1 and p3 (Fig. 18). Chaetae p6 between pso a and b on head. Th. tergum I with 7+8 chaetae, chaeta

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Figs. 16–20. *Protaphorura ianstachia* Yosii, 1972, type specimens. (16) dorsal chaetotaxy of Abd. terga V–VI; (17) chaetotaxy of Th. tergum I; (18) position of p-chaetae on posterior margin of head; (19) position of pseudocelli and p-chaetae in midsection of Abd. tergum I; (20) medial part of Abd. sterna II and III with mvo.

m absent Fig. 17). Th. terga II and III with lateral microsensilla. Chaetae s' absent on Abd. terga I–III and V (Fig. 16). Abd. tergum V with medial chaeta p_0. Abd. tergum VI with medial chaeta m_0 (Fig. 16). Base of chaetae in front of anal spines in parallel arragment. M/s ratio on Abd. tergum V as 16/10 (anal spines = 10). Anal spines slightly shorter than inner edge of claw (0.9:1) and 3.3 times longer than their basal diameter.

Ventral chaetotaxy. Th. sterna I–III without chaetae. Ventral tube with ca. 7+7 chaetae, and 1+1 chaetae at base. Chaetotaxy of medial part of Abd. sterna II–III as in Fig. 20. Mvo present on posterior edge of Abd. sternum II and anterior edge of Abd. sternum III with 2 + 2 (join chaetal socket on each side) and 1+1 modified chaetae respectively (Fig. 20). Furcal rudiment: cuticular fold (on the anterior edge of the sternum).

Distal whorl (A+T) of tibiotarsi with 11 chaetae. Claw with small denticle in the 1/2 of inner edge of claw. Empodial appendage of almost the same length as the inner edge of the claw, without basal lamella.

Remarks

Stach (1934: p. 135–136) partly redescribed *P. octopunctata* using the specimens from Caucasus. He had handled (after Stach 1954) 8 specimens from which only 2 have been found by us in his collection. One of Stach's slides contains a male, the second one shows a fragmented female belonging to another species – *P. sakatoi* (Yosii, 1966), and the third one does not contain any animal. Yosii (1972) during his research of the alpine fauna of Mt. Poroshi (Hokkaido) at the occasion of the description specimens of *O.* (*Protaphoruta*) *octopunctatus* pronounced: ". . . Accordingly, the species determined by Stach as *O. octopunctatus*, which has distinct male ventral organ, must be regarded as an independent species, for which the name *O. ianstachi* **sp. nov.** is given herewith. . . . ".

After examining the male of the Stach's collection we confirm the decision of R. Yosii.

Later additional *Protaphorura* species with 4 and more pseudocelli at antennal base were erected by Pomorski & Kaprus' (2007) as the *oc-*

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topunctata group. In the same paper they redescribed the most known *P. quadriocellata* (Gisin, 1947) and *P. octopunctata* (Tullberg, 1876) and described two new species. It was found that *P. octopunctata* was distributed only in North and Middle Siberia, whereas 15 other species from this Collembola group inhabit Europe and the Caucasus (Kaprus' & Pomorski 2008). Among them only 2 species have the mvo *P. ianstachi* and *P. eichhorni* (Gisin 1954). However, they clearly differ by the dorsal pseudocellar formula, details of chaetotaxy and location of the mvo (see key below).

Two other above mentioned species, *P. octopunctata* and *P. sakatoi*, clearly differ one from another and from *P. ianstachi* by presence/absence of mvo (present only in *P. ianstachi*) and the pseudocellar formula (42/022/33332 dorsally and 2/000/0000 ventrally, subcoxae 1 of I–III legs with 1,1,1 pso in *P. ianstachi*, 4(5,6)3(4)/022/3335(4)3(4,5) dorsally and 1/000/0000 ventrally, subcoxae 1 of I–III legs with 0,0,0 pso in *P. octopunctata*, 43/022/33343 dorsally and 1/000/0000 ventrally, subcoxae 1 of I–III legs with 1,0,0 pso in *P. sakatoi*).

Protaphorura stiriaca (Stach, 1946) (Figs. 21–26, 32)

Onychiurus stiriacus Stach, 1946: 13–17, pl. V

Type Material

Lectotype (by present designation): male Austria: Upper Styria, Enns river valley near Admont, direction to Frauen mountain, 31III1940, gap of wildbrook, from leaves of hazels, oaks, willows, leg. H. Franz. Paralectotypes: 2 males and 2 females, data same as Lectotype.

Redescription

Lectotype (male) length 1.9 mm, paralectotypes: females 1.7–1.9 mm, males 1.8 mm. Shape of body typical of the genus: cylindrical, but with very small anal spines on very low papillae (Fig. 25). Granulation more or less uniform, distinct. Base of antennae slightly marked.

Antennae of almost the same length as head. AIIIO with five guard chaetae, five papillae, two smooth sensory rods, two sensory clubs different in size: one greater, ovoid, morel-like, the other one smaller, round, sponge-like, ventro-lateral microsensillum present. Ant. IV with subapical organite in cavity, without cuticular papillae. Microsensillum on Ant. IV in usual position above second proximal row of chaetae. Sensilla indistinct on Ant. IV, ventrally Ant. IV with about 75 chaetae.

PAO with about 38–41 simple vesicles. Maxillary outer lobe with simple palp, basal chaeta and with two sublobal hairs. Labral formula: 4/342. Labial palp of type A.

Pso formula dorsally: 32/001/33232, ventrally without pso. Subcoxae 1 of I–III legs without pso. Submedial pso a and b on Abd. terga I–II placed close together (Fig. 23). Psx invisible. Psp visible only on Abd. sternum IV below manubrial area.

Dorsal chaetotaxy well differentiated into macrochaetae and microchaetae. On head the p2 chaetae displaced forward in relation to p1 and p3 (Fig. 22). Chaetae p6 on head above pso b. Th. tergum I with 9–11+9–11 chaetae, chaeta m absent (i2(3)) (Fig. 21). Th. terga II and III with lateral microsensilla. Chaetae s´ absent on Abd. terga I–III and V (Figs. 23 and 25). Abd. tergum IV with one medial chaeta m_0, Abd. tergum V with medial chaeta p_0, m_0 present or absent. Abd. tergum VI with one medial chaeta p_0 (Fig. 25). Base of chaetae in front of anal spines in parallel arragment. M/s ratio on Abd. tergum V as 54/42 (anal spines = 10). Anal spines shorter than half of inner edge of claw (0.33:1) and 2.4 times longer than their basal diameter.

Ventral chaetotaxy. Th. sterna I–III with 1,1,1 chaetae. Ventral tube with ca. 8–9+8–9 chaetae, and 1+1 chaetae at base. Mvo present on posterior edge of Abd. sternum II and III (in p-row chaetae) with 2+2 and 1+1 modified chaetae respectively (Figs. 24 and 32). Chaetotaxy of Abd. sternum IV as in Fig. 26. Furcal rudiment below one row of chaetae: cuticular fold with 2+2 dental chaetae, three manubrial rows with 4 ma, 2 mm and 6 mp chaetae.

Legs. Subcoxae 1 of I, II and III legs with 5, 6–7, 5 chaetae, subcoxae 2 with 1, 5, 5, coxae with 3, 11, 15, trochanters with 10, 11, 11, femora with 20 each, tibiotarsi with four rows of chaetae (A+T) (=distal whorl)+B+C: 11+8+5 each. Claw with strong denticle in middle of inner edge of claw. Empodial appendage almost the same length as inner edge of claw, without basal lamella.

Remarks

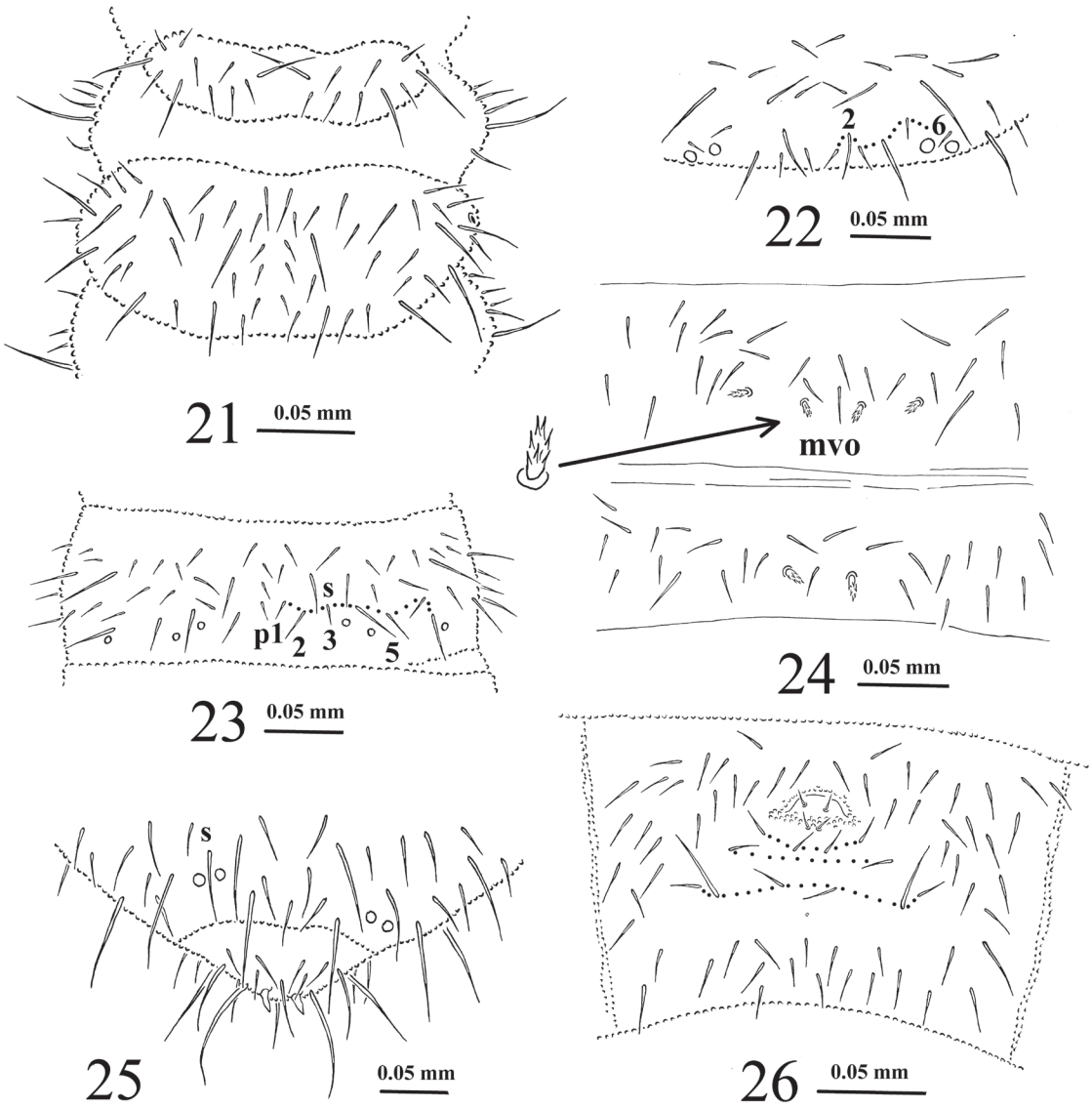
Protaphorura stiriaca has been described by Stach about 70 years ago (in 1946), when many important diagnostic characters remained unknown, but the status of this species was discussed by Pomorski et al. (2003). However, the species was never redescribed and we do so based on type specimens.

Key to Males of *Protaphorura* Species with the Ventral Organ

1. Subcoxa 1 of legs I–III with 1,1,1 or 1,0,0 pso 2

—. Subcoxa 1 of legs I–III without pso 6

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Figs. 21–26. *Protaphorura stiriaca* (Stach, 1946), type specimens. (21) chaetotaxy of Th. terga I–II; (22) position of p-chaetae on posterior margin of head; (23) chaetotaxy of Abd. tergum II; (24) mvo; (25) chaetotaxy of Abd. terga V–VI; (26) chaetotaxy of Abd. sternum IV.

2. Subcoxa 1 of legs I–III with 1,1,1 pso 3

—. Subcoxa 1 of legs I–III with 1,0,0 pso, dorsal pso formula: 3(4)3(2)/022/33(4)342(3), ventral tube with 6-8+6-8 modified chaetae . . . . . *P. stogovi* Pomorski

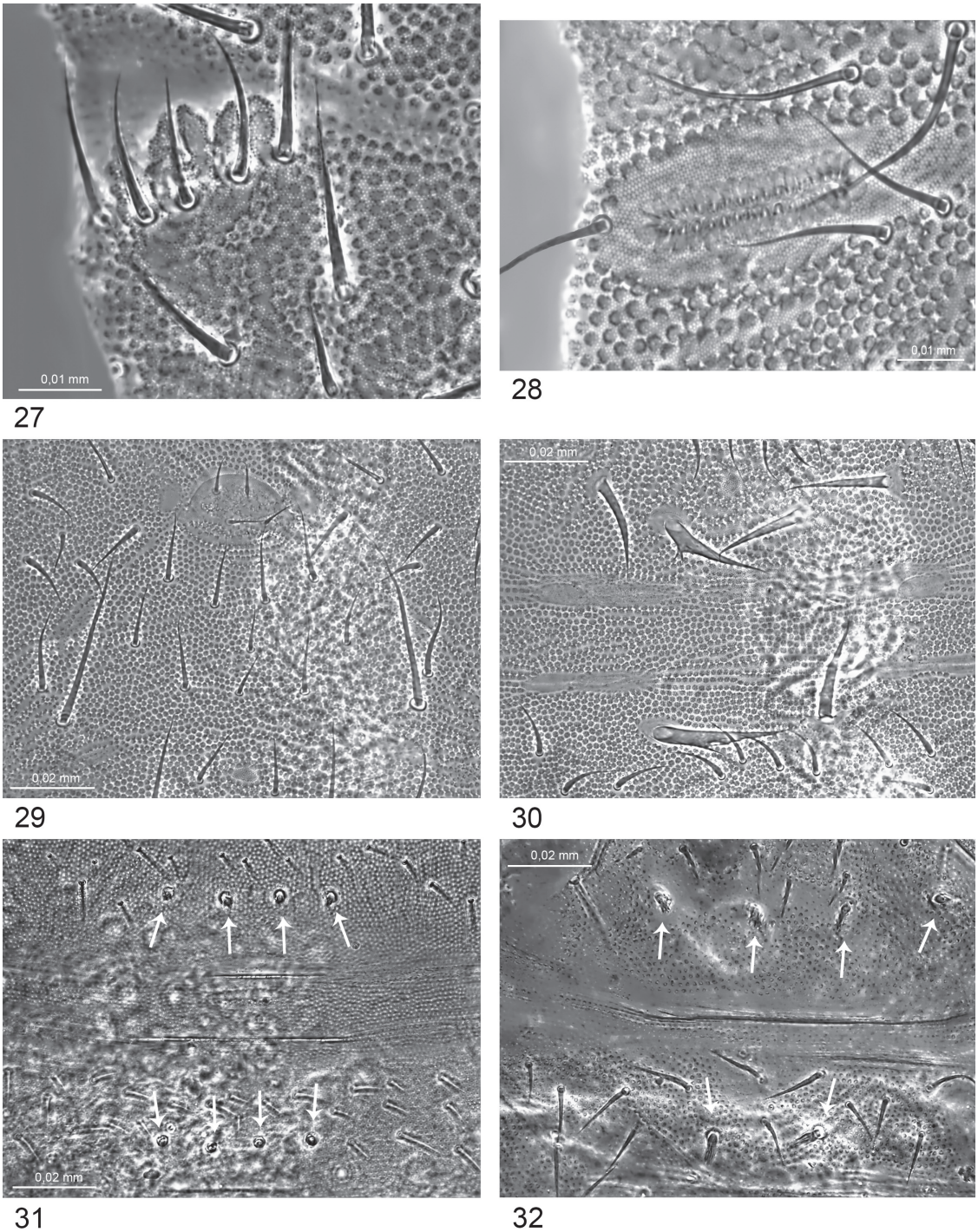
3. Base of antennae with 4 pso. 4

—. Base of antennae with 3 pso 5

4. Mvo on Abd. sternum II (posterior edge) and III (anterior edge) as 2+2 and 1+1 modified chaetae, dorsal pso formula: 42/022/33332 . . . . . *P. ianstachi* (Yosii)

—. Mvo on Abd. sternum II (posterior edge) and III (anterior edge) as modified chaetae 3 and 6 respectivelly, dorsal pso formula: 43(4)/022/3335(6)3(4) . . . . . *P. eichhorni* (Gisin)

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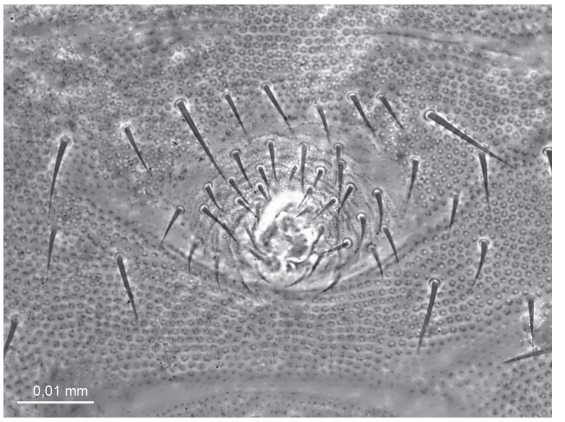


Figs. 27–32. *Protaphorura salsa* **sp. nov.**: (27) AIIIO; (28) PAO; (29) Furcal area; (30) Abd. sterna II and III with mvo, preadult male; *Protaphorura bakhchisaraica* **sp. nov.**: (31) Abd. sterna II and III with mvo, adult male; *P. stiriaca* (Stach, 1946): (32) Abd. sterna II and III with mvo, adult male. Arrows show the modified chaetae.

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Figs. 33–34. Male genital plate: (33) *Protaphorura salsa* **sp. nov.**, preadult male; (34) *Protaphorura bakhchisaraica* **sp. nov.**, adult male.

5. Mvo on ventral tube with 6+6 modified chaetae, dorsal pso formula: 33/023/33343 . . . . . *P. tricampata* (Gisin)

—. Mvo on Abd. sternum II and III (posterior edge) as 2+2 and 1+1 modified chaetae, dorsal pso formula: 33/012/33333 . . . . . *P. christiani* Pomorski, Leithner and Bruckner

6. Mvo with two modified brush-shaped chaetae on each anal valves, dorsal pso formula: 33/012/33332 . . . . . *P. minima* Sun, Zhang and Wu

—. Mvo with modified chaetae on different abdominal sterna 7

7. Modified chaetae of mvo on Abd. sterna II–IV 8

—. Modified chaetae of mvo on Abd. sterna II–III 9

8. Mvo on Abd. sterna II–IV with modified chaetae 4,10–12, 16 respectively, dorsal pso formula: 32(3)/011/23232. Anal spines very small . . . . . *P. januarii* (Weiner)

—. Mvo on Abd. sterna II–IV with modified chaetae: 7, 12, 11 respectively, dorsal pso formula 32/022/33232. Anal spines normal . . . . . *P. ajudagi* Pomorski, Skarżyński and Kaprus'

9. Mvo on Abd. sterna II–III with modified chaetae 2+2 and 1+1 respectively. 10

—. Mvo on Abd. sterna II–III with modified chaetae 2+2 and 2+2 respectively. 11

10. Dorsal pso formula: 32/001/23232, ventrally without pso . . . . . *P. stiriaca* (Stach)

—. Dorsal pso formula: 33/022/3324(3)3, ventrally: 2/000/0001 . . . . . *P. salsa* **sp. nov.**

11. Dorsal pso formula: 32/022/33332, ventrally: 2/000/0001, thickened chaetae on ventral tube absent . . . . . *P. kopetdagi* Pomorski

—. Dorsal pso formula: 32/01(2)2/331(2)32, ventrally: 2/000/0000, ventral tube with 4+4 thickened chaetae . . . . . *P. bakhchisaraica* **sp. nov.**

ACKNOWLEDGMENTS

We are most grateful to Sophya K. Stebaeva, Yurij Chernobay and R. Jacek Pomorski who supplied us with the material described in this study. The authors' research was funded under the agreement on scientific cooperation between the Polish Academy of Sciences and the Ukrainian National Academy of Sciences (Project for 2012-2014).

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